

Right Ventricular Tissue Doppler in Space Flight

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Background

Tissue Doppler (TD) registers movement of a given sample of cardiac tissue throughout the cardiac cycle. TD spectra of the right ventricle (RV) were obtained from a long-duration ISS crewmember as a portion of an ongoing experiment ("Braslet" test objective). To our knowledge, this is the first report of RV TD conducted in space flight, and the data represent reproducibility and fidelity of this application in space and serve as the first "space normal" data set.

Methods

RV TD was performed by astronaut scientists remotely guided by an ultrasound expert from Mission Control Center, Houston, TX. In four of the subjects, RV TD was acquired from the free wall near the tricuspid annulus in two separate sessions 4 to 7 days apart. A fifth subject had only one session. All digital DICOM frames were exported for off-line analysis. Systolic (S'), early diastolic (E') and late diastolic (A') velocities were measured. RV Tei-index was calculated using diastolic and systolic time intervals as a combined measure of myocardial performance.

Results and Discussion

The mean values from the first 4 subjects (8 sessions) were used as the on-orbit reference data, and subject 5 was considered as a hypothetical patient for comparison (see Table).

| Subject | 1 | | 2 | | 3 | | 4 | | 1 - 4 | | 5 |
|--------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|----------|-------|
| Session | a | b | a | b | a | b | a | b | MEAN | σ | a |
| S' cm/sec | 14.14 | 13.55 | 13.35 | 12.23 | 16.29 | 16 | 11.73 | 13.26 | 13.82 | 1.62 | 11.93 |
| E' cm/sec | 12.93 | 10.87 | 11.1 | 16.12 | 8.9 | 9.97 | 8.34 | 12.19 | 11.3 | 2.49 | 12.43 |
| A' cm/sec | 18.36 | 14.99 | 14.08 | 14.56 | 18.3 | 16.58 | 12.69 | 18.57 | 16.02 | 2.25 | 11.07 |
| RV Tei-index | 0.62 | 0.53 | 0.3 | 0.32 | 0.55 | 0.58 | 0.49 | 0.4 | 0.46 | 0.14 | 0.43 |
| Heart Rate | 56 | 53 | 74 | 71 | 60 | 60 | 58 | 54 | 60.92 | 7.47 | 57 |

The greatest difference was in the early diastolic A' (31%) yet the standard deviation (σ) for A' amongst the reference subjects was 2.25 (mean = 16.02). Of interest is the Tei index, a simple and feasible indicator of overall ventricular function; it was similar amongst all the subjects. The late diastolic A' seems to compensate for the variance in E'. Normal Tei index for the RV is < 0.3, yet our data show all but one subject consistently above this level, notwithstanding their nominal responses to daily exercise in microgravity. These data remind us that the physiology of RV preload in altered gravity environments is still not completely understood.